Optimal Choice of Material for HEB Superconducting Mixers

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We demonstrate that a potential distinction in ultimate performance of phonon-cooled and diffusion cooled HEB mixers is not due to the cooling mechanisms but rather due to the different properties of available superconductors. The only available material for a phonon-cooled mixer with sufficiently large IF bandwidth (~4 GHz) is NbN, whereas a variety of clean materials (e.g., Nb, NbC, Al) are suitable for diffusion-cooled mixer. For a readily achievable device length of 0.1 micron for example, the IF bandwidth can be ≥ 10 GHz. The requirement of low local oscillator (LO) power can also be more easily met in diffusion-cooled devices by selection of the material with lower critical temperature and low density of electron states. In contrast, the parameters in the NbN mixer cannot be widely varied because of the high resistivity of the material and the necessity of using ultrathin films. Given the limited availability of LO power from compact of solid-state sources at frequencies above a THz, an Al diffusion-cooled mixer is the most attractive choice for low-background radioastronomy applications.

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